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EVIDENCE OF ALTERNATIVE INHERITANCE IN THE F_2 GENERATION FROM CROSSES OF *BOS INDICUS* ON *BOS TAURUS*

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THE common domestic cattle of India appear to be a distinct species (*Bos indicus*). They are mainly characterized by a large hump on the fore shoulders, short horns, large drooping ears, extensive dewlap and sheath (Fig. 1). There are several varieties, or breeds, but they are so commonly hybridized that it is exceedingly difficult to ascertain which are the pure strains and which hybrids. In this respect they are probably analogous to *Bos taurus*. In size they vary greatly, ranging from very diminutive breeds to those the largest individuals of which weigh upwards of 2,000 pounds. The males are considerably heavier than the cows. The colors also vary considerably, the most common being creamy buff, brown, ashy gray, red, black and white, and blends of these.

They appear to be highly resistant to the cattle diseases of tropical and subtropical countries, and they are immune to the attacks of cattle ticks, that is, ticks do not remain attached to them and suck their blood (Figs. 1 and 9), and they are said to be less liable to suffer from the effects of the bites of insects than any of the breeds of *Bos taurus*.

They are very gentle and docile. In India the males are used as beasts of draught, and are yoked to the plow, being the main animal used for tilling the ground. They are very agile, being able to travel thirty or more miles a day, carrying a heavy burden, or drawing a cart with a considerable load on it. Recently they have been introduced into Jamaica in considerable numbers, where they

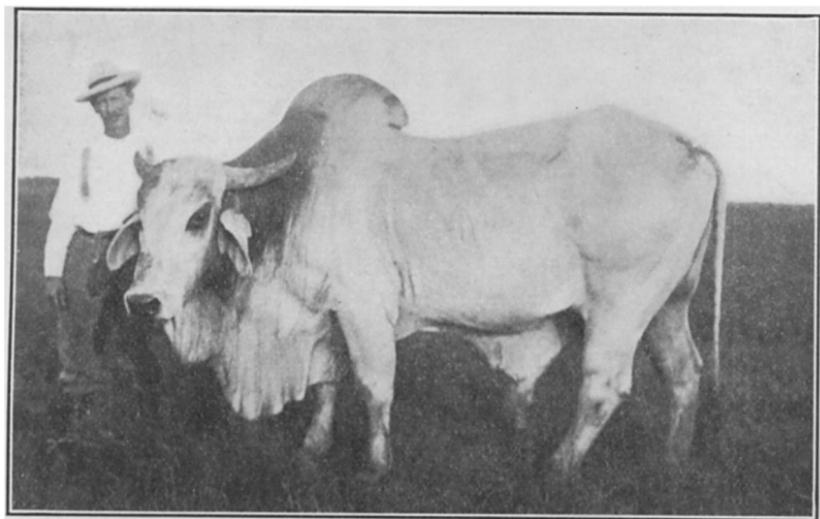


FIG. 1. Imported bull (*Bos indicus*). When in good condition, this bull weighs 2,000 pounds.

are used on the banana plantations. It is generally reported that the strong draught oxen of Spain have been derived from crosses between Indian cattle and the native Spanish cattle, but the evidence is at best only anecdotal and nothing whatsoever seems to have been recorded of



FIG. 2. Cows and calves (*Bos indicus*).

the inheritance behavior of the progeny of any of the crosses.

The hump of some of the largest specimens may weigh as much as fifty pounds, and it is esteemed by English residents of India as a delicacy for the table. From the Persian province of Gilan, on the Caspian, the humps, smoked, of a small breed are shipped to parts of Russia where they are in much demand as a delicacy. The meat, products of these cattle, on the whole, are said to be unexcelled. Some of the breeds give milk that is excessively rich in quality, but it does not appear that any of them produce it in large quantities.

It appears that Brahma (*Bos indicus*) cattle were first brought to the United States in 1853 by Mr. Davis, of South Carolina. These cattle were subsequently taken westward and their progeny distributed throughout the southwest and parts of Mexico. In southern Texas and parts of Mexico there are many native cattle that are said to carry the blood of these cattle and other Indian stock which were secured from menageries and circuses. The common brindle cattle of these regions are said to be descendants of the Indian on native cattle. Wherever these part Indian cattle are found there is a general impression among stockmen that they are thriftier and larger than the native stock and more resistant to the ravages of diseases, ticks, and insect pests.

In 1906 Mr. A. P. Borden, of Pierce, Texas, imported about thirty head of Brahma cattle, mostly young bulls, and since then he has been crossing them quite extensively on native Texas cattle and on grade Durhams and on grade Herefords. For an account of the experiences in importing these cattle and the beginning of the experiment, the reader is referred to Mr. Borden's interesting paper, "Indian Cattle in the United States," *The American Breeder's Magazine*, Vol. 1, No. 2.

In September, 1911, Mr. Borden kindly permitted me to visit his herds for the purpose of studying them and making photographs. The following preliminary ac-

count of three of the herds is given, because they tend to show definite inheritance results. The study of the herds and the work of making the photographs were greatly hampered by the absence of the head herdsman, the rain,



FIG. 3. F_1 hybrids from *Bos indicus* on Hereford. The heifer on the right weighed 1,000 pounds at twelve months of age. The bull on the left weighed 1,450 pounds at twenty-six months of age. Photo furnished by Mr. A. P. Borden.

and the very short time at my disposal. I plan to make a further study of them at an early date.

Whenever the Brahma cattle have been crossed on grade or pure Herefords, the color characters of the latter are on the whole dominant in the F_1 progeny (Figs.



FIG. 4. Hybrids from *Bos indicus* on Hereford and Durham. The bull in the center is from Hereford mother and weighed about 1,400 pounds at 22 months of age. All are tick-free.

3 and 4). The F_1 progeny from crosses on grade Durham show the Durham color and other characters to be dominant. The progeny from crosses on native Texas cattle of unknown constitution are very variable. In some cases the F_1 progeny from the latter resemble the Brahma greatly. However, this apparent dominance of the Brahma in many cases, when crossed on native cattle, is probably altogether due to the fact that a considerable proportion of the native cattle already have Brahma characters in them—their immunity to ticks and other desirable qualities having favored their perpetuation since the early introduction of the Davis and other Brahma stock.

HERD No. 1

This herd consists of twenty-five or thirty F_1 cows (Fig. 5, adults) from a white Brahma sire on grade Dur-



FIG. 5. F_1 mothers from *Bos indicus* on grade Durham and a few grade Herefords. The white calf, on the right, is from F_1 half-brother of the cows. The pure Durham calf, on left, and hybrid in center are from Durham sire.

hams and a few grade Herefords. Twenty-four of these F_1 cows were mated to their Brahma-Durham F_1 half-brother, and eighteen F_2 calves were produced. Of these, six are white and resemble the grandfather white Brahma. One of the calves is shown in Fig. 5, on the right. The remaining twelve F_2 calves from these crosses of hybrid \times hybrid resemble the Durham mostly,

though there is evidence of the Hereford characters in a few. A few of these F_1 cows were mated to a registered Durham bull. Only two of the F_2 calves from these crosses were observed. They are shown in Fig. 5, on the left and in the middle. The one on the left is a pure Durham in all respects. The one in the center is a typical Brahma-Durham hybrid. A downpour of rain and the scattering of the herd prevented further observations.

HERD No. 2

The F_1 cows of this herd are the product of a Brahma male on grade Hereford and grade Durham in about



FIG. 6. The cows are from *Bos indicus* on impure Durham, and the calves from these F_1 cows bred back to *Bos indicus*.

equal proportion. These F_1 cows show the color characters of the Hereford and Durham quite distinctly,



FIG. 7. The yearlings are from *Bos indicus* \times high-grade Hereford F_1 hybrids bred back to *Bos indicus*.

though there is slight evidence of the hump of the Brahma sire, and the dewlap is somewhat enlarged (Fig.

6, adult). (The brothers of these cows were not observed.) The F_2 calves of this herd are from a Brahma sire on these F_1 cows. My notes fail to show whether or not the sire of the F_2 calves is the same as that of their F_1 mothers. The sire of the F_2 calves appears to be intermediate in color between the white and brown Brahma. The calves are of two distinct types, about one-half of them having the Brahma characters and the other half bearing the characters of their hybrid mothers (Fig. 6, calves). In the figure (Fig. 6) a good type of the hybrid resembling the mother is the sucking calf at the right, while several apparently pure Brahma are shown in the foreground.

HERD No. 3

The F_1 cows of this herd are the progeny from a Brahma sire on high grade Hereford cows. The F_2 calves and yearlings are from another Brahma sire on the Brahma-Hereford hybrid. On counting these thirty-two calves and yearlings, it was found that seventeen of them resemble mostly the sire and grandsire Brahma while fifteen come nearer to the type of the hybrid mothers (Fig. 7, calves and yearlings).

CONCLUSIONS CONCERNING THE INHERITANCE BEHAVIOR

It appears that the color patterns of Herefords and Durhams are dominant in the F_1 generation. However, the hump, large sheath and dewlap of the Brahma show slightly in the Brahma \times Hereford or Durham F_1 progeny. It is clear that in the F_2 generation, pure Brahma and pure Durham are segregated. Indications are that when the parent strains are pure the segregation follows the simple law of alternative (Mendelian) inheritance. However, the conditions of the experiment, the lack of full knowledge of the constitution of the parents and the inadequate observations prevent any positive conclusions as yet concerning the ratios.

IMMUNITY TO THE TEXAS CATTLE TICKS

I am able fully to confirm Mr. Borden's statements (*loc. cit.*) that the pure Brahma cattle and the hybrids are perfectly immune to the Texas cattle tick. Fig. 8 shows the ordinary conditions of the native Durham or Hereford cattle, while Figs. 9, 1 and 3 show the condi-



FIG. 8. A tick-infested Hereford cow.

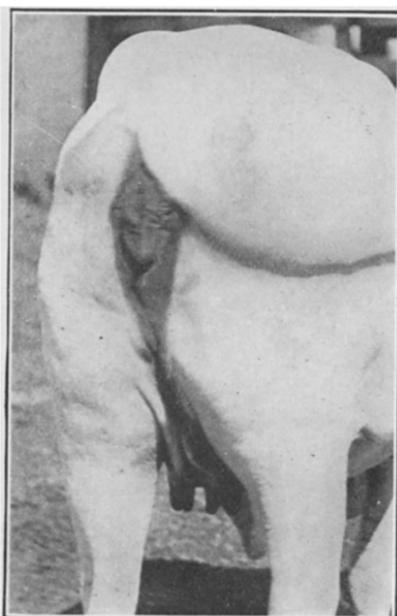


FIG. 9. A *Bos indicus* cow free from ticks.

Each of these cows has suckled a calf during the summer and both have been together in the same pasture.

tions of the pure Brahma and hybrids all running together on the same range. I was not able to ascertain definitely the inheritance behavior of this character (immunity to ticks) in the F_2 progeny. However, it is expected that data on this point will be available in the spring or summer of 1912.

SIZE AND PROLIFICNESS

The statement by Mr. Borden (*loc. cit.*) that the hybrids running on the range average about 50 per cent.

larger than the ordinary native range cattle is fully confirmed by my observations. The hybrids shown in Fig. 4 (center), which had had no other advantage than the range conditions, weighed 1,400 pounds at two years old. The hybrid heifer, shown in Fig. 3 (at the right), which had run on the range, weighed 1,000 pounds at twelve months old. The bull, Fig. 3 (on the left), weighed 1,450 pounds at 26 months of age. These weights appeared to me to be more than 50 per cent. greater than the average of the native cattle at the same age kept under similar circumstances.

A pure Brahma bull will put seventy-five to eighty cows with calf each season, while the native or even high-grade Hereford or Durham will impregnate only twenty-five or thirty cows.

I desire to express my gratitude to Mr. Borden for courtesies shown me while studying and photographing the herds and for reading and correcting the manuscript, and to Professor T. J. Headlee for the arrangements which made the trip possible; I am further indebted to Professor Headlee for suggestions while writing the paper and arranging the illustrations.